SUMMARY

The Charlotte-Mecklenburg Utilities (CMU) of North Carolina has maintained an SSO database under their Complaint History And Maintenance Processing System (CHAMPS) for at least 15 years. This database provides detailed information on each reported SSO and all the sewer system maintenance activities under CMU's jurisdiction. This database, along with several other data sources, formed a supporting ground to study the relationship between the monthly SSO frequency and several major SSO factors, with an emphasis on the impact of pro-active sewer system maintenance activities.

The statistical relationship, between the SSO frequency and the levels of its factors, was gauged by a Poisson Regression Model.

The study results support the following statements:

1. The seasonal change of the sewer system condition is the single most powerful factor in explaining the fluctuation of the SSO frequency in time. It explains approximately 24.1% of the total variation in the observed SSO occurrences.

2. A higher level of pro-active sewer system maintenance activities lowers the SSO frequency. The maintenance activity factor explains approximately 16.42% of the total SSO variation in time. This fact establishes a qualitative as well as a quantitative relationship between pro-active sewer maintenance activities and SSO frequency.

3. The total wastewater flow to the treatment plants, a measure of the system load, is also explanatory. It explains approximately 9.2% of the total variation of SSO in time. The impact of the flow does not seem to be as strong as that of seasonal change or that of pro-active maintenance activities.

4. A maintenance program with an intelligent scheduling mechanism lowers the SSO frequency. The Schaaf-like scheduling methodology adopted by CMU explains approximately 4.48% of the total SSO variation in time.

5. The total impact of human effort to improve the sewer condition (pro-active maintenance activities and intelligent scheduling methodologies) is less than the impact by the seasonal changes. The numerical comparison is 20.9% versus 24.1%.

6. Given the mixture of the maintenance activities at CMU for the last fourteen years, the study suggests a ranking of maintenance types by their relative strengths (RS) in reducing the frequency of SSO. The ranking * is:

    a) Rapid Response (RS=30.16%),
    b) Scheduled Inspection (RS=20.41%),
    c) Rodder (Root Removal) (RS=16.42%),
    d) Right-of-Way Mowing (RS=12.18%),
    e) Herbicide Application (RS=11.78%),
    f) Off-Street Maintenance (RS=10.58%),
    g) T.V. (RS=0.44%),
    h) Jets & Combination Machines (high pressure water jets) (RS=-2.66%), and
    I) Manhole Inspection and Cleaning (RS=-3.07%).

7. While all the above statements are strongly supported by statistical evidence from the CMU data, the final regression model only explains approximately 64.05% of the total variation. This fact suggests that while we can identify and even quantify some of the major SSO factors with statistical confidence, there is still 35.95% of the SSO fluctuation unexplained.

8. The unexplained SSO variation, along with the fact that human controlled activities are associated with only 20.9% of the total fluctuation, suggest that some of the common beliefs regarding Type *B*** SSOs should be re-examined. In particular, the belief, that SSOs will be controlled if the flow to the system is controlled, needs to be seriously re-considered. The study results suggest that only 9.2% of the SSO problem may be attributed to the flow in the system. Another prevalent belief regarding SSOs is that SSOs can be controlled if a "reasonable maintenance program" is in place. This study suggests that the intensity level of such a "reasonable maintenance program" may be quite a distance away

from the current intensity level in practice.

All the above statements are made based on the inferences drawn from the statistical models employed. Since any statistical model is, at its best, an approximation to the true state of nature, these statements should not be taken as final conclusions, but as mere suggestions or references for future tests and researches.

* See Section 3.06 for detailed interpretation.

** See Section 1 for the definition of Type *B* SSO.